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ORIGINAL ARTICLE

SEED GERMINATION: A CONCEPTUAL REVIEW

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ABSTRACT

In biology, a **seed** is a plant in its **embryonic stage** that is encapsulated in a **seed coat**. In addition to a plant embryo, the seeds of most plant species also have food reserves. When the soil moisture and temperature conditions are favourable for growth, seeds "wake up." The collection of active metabolic processes that lead to the emergence of a new seedling is called **seed germination**. In crop production factors such as seed quality, environmental conditions (temperature, moisture, light), and planting depth can significantly influence germination rates. Successful germination ensures that a plant establishes itself well, leading to healthy crop stands. In addition to crop production, seed germination is vital for the conservation and restoration of native plant species and ecosystems. Seeds of native plants are collected, stored, and germinated to propagate species for habitat restoration, reforestation, and biodiversity conservation efforts. Understanding the germination requirements of different species is essential to ensure the successful establishment of these plants in their natural habitats. In this Paper a modest attempt made to study the seed germination concepts, types, conditions that require for healthy seeds germination.

KEY WORDS: Biodiversity, Epigeal germination, Hypergeal germination, Inbibition, Seed Germination.

INTRODUCTION

Seed germination is a critical phase in the life cycle of plants, influenced by factors like temperature, moisture, and light. The germination process is highly sensitive to environmental conditions, with temperature and moisture playing key roles in triggering seed dormancy release and subsequent growth. Seeds undergo various stages before germination, including the accumulation of food reserves necessary for the growth of the embryo. The structure of a seed is complex, consisting of the seed wall, embryo, endosperm, and a variety of components such as carbohydrates, proteins, lipids, minerals, nucleic acids, alkaloids, growth hormones, amino acids, and phenolics. The internal and external structures of seeds vary significantly, impacting dispersal and germination methods. Seed germination is an important aspect in plant growth as the higher the quality of seed germination, better the yielding. The term germination in the seeds of higher

plants (Angiosperms) refers to the protrusion of a root or shoot from the seed coat, while emergence is the visible penetration of the shoot above the soil surface (Hadas and Russo 1974, Hadas 1976, Benech Arnold et al., 1991). In order that a seed can germinate, it must be placed in environmental conditions favorable to this process (Craufurd et al., 1996). Among the conditions required is an adequate supply of water, a suitable temperature range and, for some seeds, light (Collis George and Williams 1968, Levitt 1980, Long and Woodward 1998). Germination is the crucial and final event in the life of a seed. It represents both the fulfillment and the completion of the basic function of seed - propagation. Seed - to be sure - have other functions in modern agriculture. They are the main mechanism by which improvements genetically engineered into plant populations are transmitted from one crop generation to another. They also function very efficiently as a convenient means of distributing plant populations throughout areas of adaptation. The latter two functions, however, are wholly dependent on germination. A seed that has lost its capacity for germination can neither transmit genetic improvements nor function in the distribution of desirable plant populations from one place to another (James and Delouche, 1979).

TYPES OF SEED GERMINATION

There are two main types of seed germination--epigeal and hypogeal germination--which indicate whether the cotyledonary node is above or below ground during germination.

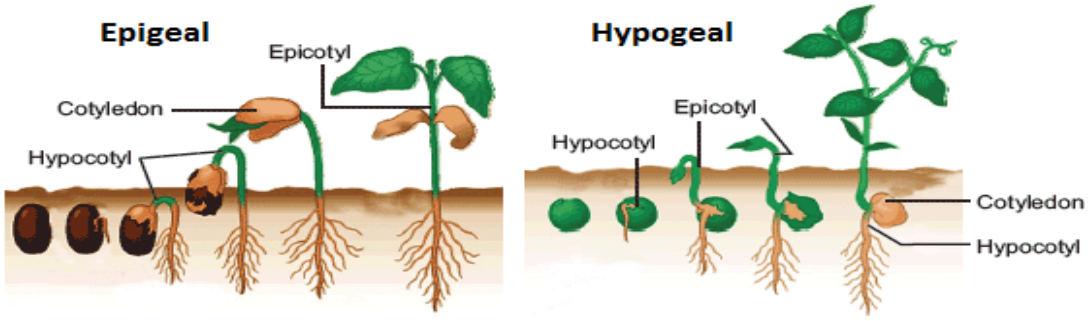
The rate of cell division in the plant's hypocotyl area during germination and early seedling growth influences the position of the cotyledon. The epicotyl is the embryonic shoot region above the cotyledon attachment point, while the hypocotyl is the embryonic region below the cotyledon attachment point and continues down to the root.

Epigeal Germination

In epigeal germination, cell division in the hypocotyl is faster and more vigorous than cell division in the epicotyl. The hypocotyl's actively growing meristem induces cell growth and extension, pushing portions of the hypocotyl, the cotyledonary node, and epicotyl, above the ground.

Hypogeal Germination

In hypogeal germination, cell division in the apical meristem at the end of the epicotyl is faster and more vigorous than in the hypocotyl. The cotyledons and all the hypocotyl stay below the soil surface as a result of this cell division and elongation. The cotyledonary node, then, is found below ground.



Importances of Seed Germination

In crop production factors such as seed quality, environmental conditions (temperature, moisture, light), and planting depth can significantly influence germination rates. Successful germination ensures that a plant establishes itself well, leading to healthy crop stands. In addition to crop production, seed germination is vital for the conservation and restoration of native plant species and ecosystems. Seeds of native plants are collected, stored, and germinated to propagate species for habitat restoration, reforestation, and biodiversity conservation efforts. Understanding the germination requirements of different species is essential to ensure the successful establishment of these plants in their natural habitats.

Seed germination is also an essential aspect of crop genetics research. Researchers often study the genetic factors that affect germination rates, speed, and uniformity. By understanding the genetics behind seed germination, plant breeders can develop improved crop varieties that exhibit traits like rapid and uniform germination. This can lead to crops with better resistance to environmental stresses, such as drought or high salinity, and enhanced adaptability to changing climatic conditions.

It can play a role in disease management strategies. Pathogens can sometimes infect seeds or seedlings, leading to reduced germination rates or poor seedling vigour. Studying germination in the context of disease can help researchers identify which pathogens affect seeds, how they spread, and how to develop control measures to prevent or mitigate their impact. Seed treatments, such as fungicide coatings, can be used to protect seeds from disease and improve germination rates.

CONDITIONS NECESSARY FOR SEED GERMINATION

Water

- Water plays an important role in seed germination
- It helps by providing necessary hydration for the vital activities of protoplasm
- It provides dissolved oxygen for the growing embryo, softens the seed coats and increases the seed permeability
- It also helps in the rupturing of seed and also converts the insoluble food into soluble form for its translocation to the embryo

Oxygen

- It is an important and essential source of energy required for seed growth
- It is required by the germinating seed for the metabolism
- It is used as a part of aerobic respiration until it manages to grow green leaves of its own

Temperature

- For a seed to germinate, it requires a moderate temperature of around 25-30°C
- Different seeds require different optimum temperatures
- There are some seeds which require special requirements either lower or higher temperature between 5 to 40°C

Light or darkness

- This can act as an environmental trigger
- Many seeds refuse to germinate until sunlight falls on them

The process of seed germination, under favourable conditions, triggers the seed to undergo a rapid expansion growth of the embryo.

STEPS OF SEED GERMINATION

Germination is the process by which a seed begins to grow and develop into a new plant. It involves the activation of the dormant seed and the emergence of the seedling from the seed coat. The germination process can be divided into several stages:

1. Imbibition:

- **Absorption of Water:** The process starts with the absorption of water by the seed. Water activates the enzymes and metabolic processes within the seed.
- **Seed Swelling:** The absorbed water causes the seed to swell, leading to the softening and splitting of the seed coat.

2. Activation of Metabolic Processes:

- **Enzyme Activation:** The absorbed water activates enzymes in the seed, which in turn activate metabolic processes. These enzymes break down stored nutrients in the endosperm or cotyledons into simple sugars, amino acids, and other nutrients that are essential for seedling growth.

3. Resumption of Cellular Metabolism:

- **Respiration:** The seed starts cellular respiration to convert stored nutrients into energy (ATP) for the growing seedling.

4. Radicle Emergence:

- **Radicle Growth:** The first root, called the radicle, emerges from the seed and grows downward. It is the embryonic root of the plant.

5. Shoot Emergence:

- **Hypocotyl Growth:** The hypocotyl, the stem-like structure between the radicle and the cotyledons, elongates and pushes the cotyledons above the soil.
- **Cotyledon Unfolding:** The cotyledons, if present, unfold and become exposed to light and air.

6. Photosynthesis and Autotrophic Growth:

- **Initiation of Photosynthesis:** The cotyledons or the first leaves start photosynthesis, producing food (glucose) using light, carbon dioxide, and water.
- **Nutrient Absorption:** The seedling begins absorbing nutrients from the soil through the roots.

7. Establishment of Seedling:

- **Formation of True Leaves:** True leaves, distinct from cotyledons, begin to grow and carry out photosynthesis.
- **Root Development:** The root system develops further, anchoring the seedling and absorbing water and nutrients from the soil.

8. Continued Growth and Development:

- **Leaf Expansion:** The seedling continues to grow, with stems elongating, leaves expanding, and the plant establishing itself as a young seedling.
- **Vascular Tissue Development:** Vascular tissues, such as xylem and phloem, develop to facilitate water and nutrient transport.

Germination is influenced by various factors including water availability, temperature, light, and oxygen levels. Each plant species may have specific germination requirements, and understanding these requirements is essential for successful cultivation. After germination, the plant undergoes further growth and development, eventually leading to maturity and reproduction.

CONCLUSION

In conclusion, understanding the physiology of seed germination and the biochemical composition of seeds is essential for optimizing plant growth and development. Natural Fartisers has shown promise as a natural and sustainable solution for improving seed germination and plant growth, and biochemical tests can provide valuable information about seed quality and plant health.

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